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Skill Transfer and Virtual Training for IND Response Decision-Making: Models for Government–Industry Collaboration for the Development of Game-Based Training Tools

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5 May 2016

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EXECUTIVE SUMMARY

Game-based training tools, sometimes called “serious games,” are becoming more accepted and validated as methods for augmenting and modernizing training and evaluation. Emergency management training programs wishing to include game-based training in their curriculums face a number of practical barriers; most importantly, the risk of failing to produce a usable tool at the end of a project. That risk stems from several sources: (1) an unfamiliarity with how to build serious games; (2) the fact that developing an interactive tool like a game is a more complex, albeit not necessarily more expensive, process than developing other types of software; and (3) the unique requirements for creativity and iteration that are inherent in the game development process. These risks can be greatly mitigated if the sponsoring agency selects an appropriate program structure that leverages existing talent from the video game industry, supports an iterative design and development process, and draws on a wider range of sources of creative ideas, involving a larger number of contributors in the process.

In this document, we describe seven programmatic structures that can be leveraged to create game-based training materials. We describe the tradeoffs of the different development approaches, with the goal of helping agencies interested in serious games select an appropriate model for collaborating with partners. With an understanding of the possible collaboration models, we believe that agencies will be able to explore the use of game-based training with modest budgets and with a tolerable level of project risk.

In order to make this document accessible to readers who are new to serious game development, we first characterize the problem space in terms of the tasks that need to be accomplished for designing a game-based training tool. Next, we present the key organization types that will contribute to completing the game-design tasks, followed by a section describing how the different organizations match favorably to the different tasks. The organization types include: government agencies and training organizations, national laboratories and federally funded research and development centers (FFRDCs), academic researchers in cognitive science, academic researchers in game development, members of the video game industry, general-purpose software developers, and community participants and volunteers. Then we describe a set of collaboration models that we have identified as pragmatic approaches to developing game-based training tools. The collaboration models discussed are: traditional project sponsorship, game design competition, project bidding and development platform, academic capstone project, commercial dual release, special game mode, and center of excellence. Finally, we discuss the tradeoffs of each approach, potential variations of the individual development approaches, and opportunities for hybrid approaches with the goal of helping the reader to select an appropriate model for their program objectives.

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1. INTRODUCTION

The use of interactive digital simulations for modernizing professional training, often referred to as game-based training or “serious games,” has attracted a growing interest in both the research and training communities [1, 2, 3, 4]. Game-based training for emergency management professionals can complement traditional training methods such as classroom learning, live exercises, and on-the-job experience. Game-based training offers a number of appealing benefits to traditional methods, such as reduced cost, greater accessibility, flexible scenario creation, and increased motivation for participation. Game-based training can also effectively engage participants in a variety of complex decision-making environments that are not easily replicated by other training methods [5]. These environments can require the participants to use cognitive and social skills and accelerate experience through diverse scenarios.

Creating game-based training tools for emergency management presents unique challenges, as game design often requires multidisciplinary contributors to develop a successful product. The diverse set of stakeholders, which includes the sponsoring government agencies, game developers, and those who may benefit from the training, necessitates collaboration between multiple organizations, which can lead to a challenging management and development process. The goal of this document is to focus on the practical question of how to leverage existing talent in the commercial, academic, and federally funded research and development center (FFRDC) communities to help interested government agencies create effective game-based training tools. The development of these types of tools has much in common with the development of other software products, but there are some important differences that must be taken into account. The creation of game-based training tools is still an emerging area and, as a result, these training platforms typically involve more creative design input and more rigorous scientific validation than conventional software projects. Therefore, the successful development of game-based training tools will likely require collaboration between several different contributors bringing different areas of expertise to bear.

The analyses and recommendations in this document are supported by the input of a serious games focus group held at the Massachusetts Institute of Technology in August 2015. The focus group brought together working professionals and thought leaders from academia, government, national laboratories, and the commercial game industry to discuss practical paths forward for creating stronger collaborations in the area of game-based training.

Figure 1. Document organization.

Figure 1 describes the structure for this document. We first characterize the problem space in terms of the tasks that need to be accomplished for designing a game-based training tool. Next, we present the key organization types that will contribute to completing the tasks, followed by a section describing how the different organizations match favorably to the different tasks. Then we describe a set of collaboration models that we have identified as pragmatic approaches to developing game-based training. Finally, we discuss the tradeoffs of each approach, potential variations of the individual development approaches, and opportunities for hybrid approaches, with the goal of helping the reader to select an appropriate model for their program objectives.

2. TASKS FOR GAME-BASED TRAINING DESIGN

Creation of a digital training simulation is similar to other software products; it must be designed, developed, validated, and deployed. Along with those technical tasks, games require three additional steps to ensure they are relevant to the desired training material: needs analysis, scenario creation, and curriculum integration must be performed. Figure 2 outlines these seven main tasks that must be completed for a game-based training tool to be created and have the desired impact. The connections and adjacencies of the tasks are suggestive of how the tasks are interrelated and show which tasks can be performed in parallel. There will naturally be many additional feedback loops in the progression of a program that are not depicted. The relative importance of these tasks may vary depending on the goals of the project, but they will all be present in all projects to some degree. Next, we describe each of the seven tasks.

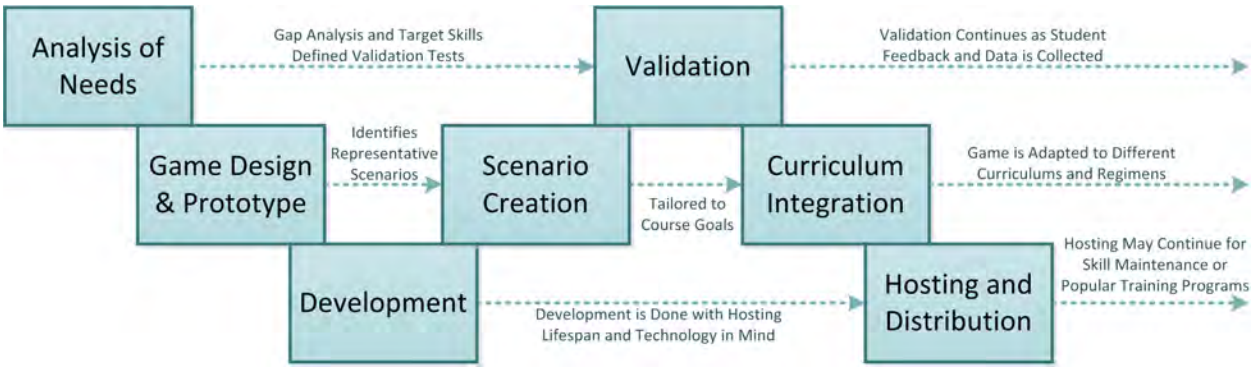

Figure 2. Seven tasks involved in the creation of effective game-based training materials.

- **Analysis of Needs:** The training need and programmatic objectives are articulated so they can guide the appropriate design or selection of a game. For example, what skills or decisions should be targeted, what scenarios are likely or of particular concern, and what type of decision maker is going to be the target beneficiary of the game?

  In this step it is also important to consider whether a game is appropriate for the desired goals of the training. Games are an effective method for engaging the participant in a dynamic decision-making environment and allowing the participant to understand the impact of using different strategies. Games are also a powerful tool for the training staff, enabling the capability to generate randomized modifications to the game scenario to ensure students are learning the desired material and not just memorizing the solution. Examples of the types of decisions and skills we have investigated for game-based training are documented in another report [24]. Game-based training is not always the best tool, and conventional training and exercises should still be employed to meet needs that they are well suited for, such as rehearsing procedures, learning factual information, and building connections between organizations via social

interaction. The Analysis of Needs stage should identify what type of training material will be best suited to meet existing gaps.

- **Game Design and Prototype:** A suitable game is designed or adapted from a prior design template. A prototype of the design should be created to get feedback from the target user base and to calibrate scoring rules and scenario difficulty. At this stage, the design could be as simple as a description of the rules and mechanics but should offer some ability, even if on paper, to be played and tested. The game design might need several iterations to match it to the target audience's needs.

- **Development:** A full working version of the game is created. This version will be based on the approved prototype, but implemented in software, with improved graphics, stability, additional gameplay content, and instrumented data tracking. The developed game will include several scenarios to represent the range of possibilities, but the main focus will remain on the core engine for the game mechanics.

- **Scenario Creation:** A larger suite of scenarios is created. A tool that can automatically or manually generate new scenarios from seed data may also be created. Different scenarios can target different situations (e.g., a high surge hurricane vs. a high wind hurricane), different user bases (e.g., a weather analyst vs. an emergency manager), or different threats (e.g., a false positive vs. a true threat). For certain games, a scenario editor may also be part of this process, allowing end users to create novel scenarios from their own experiences.

- **Validation:** A formal analysis of the efficacy of the game involves trials with human subjects. The level of rigor may vary depending on the project, but some level of confirmation will be important to any project. Validation may be an informal assessment by experts, a self-assessment survey of users, a formal performance evaluation such as a test, a material retention study conducted over time, or any combination of these techniques.

- **Curriculum Integration:** The game is integrated with appropriate complementary training materials. For example, the game might be paired with (1) a preexisting appropriate training course as is, (2) a training course where supplemental written material might need to be revised, or (3) a program for skill maintenance might need to be created to encourage users to keep using the game over time.

- **Hosting and Distribution:** The game is hosted so that it can be accessed by users – both trainers and students. Depending on the program objectives of the game, it might be available only with a matching course registration, to all professionals in the field, or to the general public. It might need to be available all the time for skill maintenance or only on occasion in support of periodic training programs.

In conclusion, many of these tasks will be completed within the scope of the initial program. However, some tasks may exist past the end of the initial program. The validation of the game may evolve into a continuous process, revising game content based on user feedback, while the evolution of certain curricula may require the game to be modified.

3. CONTRIBUTING ORGANIZATIONS

For each of the tasks outlined in the previous section, there are one or more roles to play; one organization will be the lead for accomplishment of the task but may require support from other contributors with complementary strengths. It is unlikely that any one organization would be able to effectively lead or possibly even participate in every task. Furthermore, it would be undesirable to have one organization fill all roles, as that would discourage an iterative design process, limit the range of creative inputs, and introduce bias in the validation. However, a single organization could play a role on several different tasks. In this document, we advocate for a small set of well-selected collaborators, as it is likely to be more efficient and focused than a long list of partners.

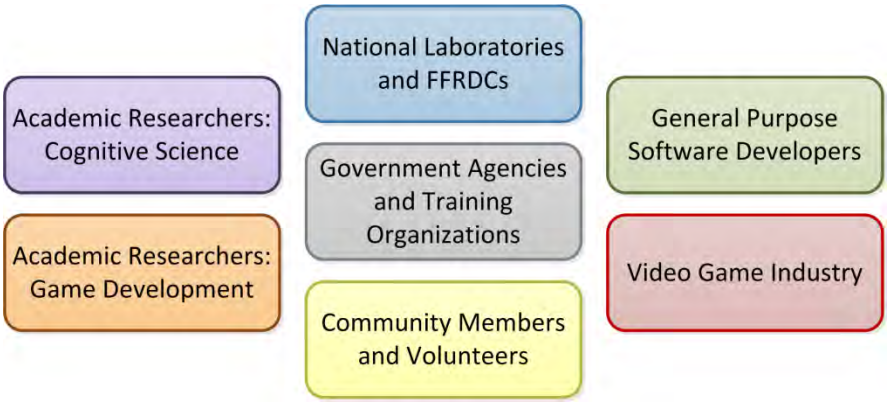

Figure 3. Potential contributors to the development of game-based training.

Figure 3 shows seven categories of organizations that could fill key roles in the development of game-based training materials. Note that not all types of organizations will fill a role in all projects, and only a select subset should be leveraged for any particular project.

- **Government Agencies and Training Organizations.** Government agencies might sponsor research, create training materials, or wish to be users of modernized training programs. They can provide domain knowledge and guide the requirements for the game. This category includes agencies such as the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), the Federal Emergency Management Agency (FEMA), and local emergency manager training divisions.

  Government agencies traditionally collaborate with contracted developers, national laboratories, and academic centers of excellence. However, they may need to forge closer connections with members of the user community, such as first responders and emergency managers, to allow those communities to be more actively involved in the creation and maintenance of the training materials.

- **National Laboratories and FFRDCs.** National laboratories and FFRDCs serve as a bridge between government agencies with technical needs and commercial contractors who can supply products to meet those needs. They also serve as unbiased advisors of the shape of a project, helping to define the requirements, perform research, and build prototypes to reduce risk and provide support to government programs.

  National Laboratories traditionally collaborate with the government (via sponsorship), industrial contractors (via tech transfers), and academic researchers (via project collaboration). To support game-based training, they may need to forge better connections with the video game industry and new types of academic departments.

- **Academic Researchers: Cognitive Science.** Academic researchers in the areas of cognitive science, psychology, and human factors can supply expertise on how to understand user behavior and needs. They can help to create and validate concepts that support human-intensive tasks, and they can bring recent research to bear on a practical problem.

  Academic research teams traditionally collaborate with government agencies via grants and center of excellence programs, as well as with national laboratories and other academic disciplines. However, those collaborations are typically isolated from each other, and may need to become part of a unified effort to support the development of game-based training.

- **Academic Researchers: Game Development.** Academic game development programs often focus on preparing students to work in the games industry. The professors have theoretical and practical knowledge of a wide range of games and how those games can target different audiences, and the students represent young talent in the areas of game design, software engineering, and the practical application of artistic skills.

  Game degree programs often collaborate with the games industry (to help their students find employment) and other academics (to further their own research). They may need to become more involved with national laboratories to better understand the serious games problem space and to leverage government training needs as an asset for providing their students with practical game development experience.

- **Video Game Industry.** The video game industry has developed a host of tools and techniques for identifying, capturing, and retaining audiences. Modern video games often utilize deep strategic decision-making experiences, compelling narrative story lines, and game mechanics to make gameplay accessible to new players, as well as visually and auditory stimulating environments to create an engaging experience for players. Many independent game developers (often referred to as “indie” developers) have novel and creative ideas for what games can accomplish.

  The games industry often collaborates with academic programs (supplying new hires) and non-game software programs (providing technical infrastructure), and they are very effective at involving their users and players in the creation of in-game content (via custom levels, strategy forums, and fan-written narrative backstories for characters). While many members of the games industry are interested in having an impact in the serious games space, they need

assistance from the other organizations listed in this section in order to forge better collaboration with government entities.

- **General-Purpose Software Developers.** There are a host of companies providing general-purpose software development services. Many of them have experience collaborating with government projects, but they are unlikely to bring to bear talent specific to the creation of games and modernized training environments.

  General-purpose software contractors might be leveraged in limited ways in such efforts, but in general, government sponsors will need to look beyond their traditional contractors to meet their needs in the area of modern training games.

- **Community Participants and Volunteers.** One of the great successes of many entertainment games is the active involvement of paying players. The experiences created by successful video games are so compelling that players volunteer their time and talent to enrich the world with custom levels, strategic forums, and narrative backstories. A similar level of engagement with relevant participants in emergency management could have a great impact on the field of emergency management game-based training. Community participants and volunteers in this domain could include professionals who would be the planned users of the game, general gamers who are intrigued by disaster response, or members of the public who want to be involved in community preparation.

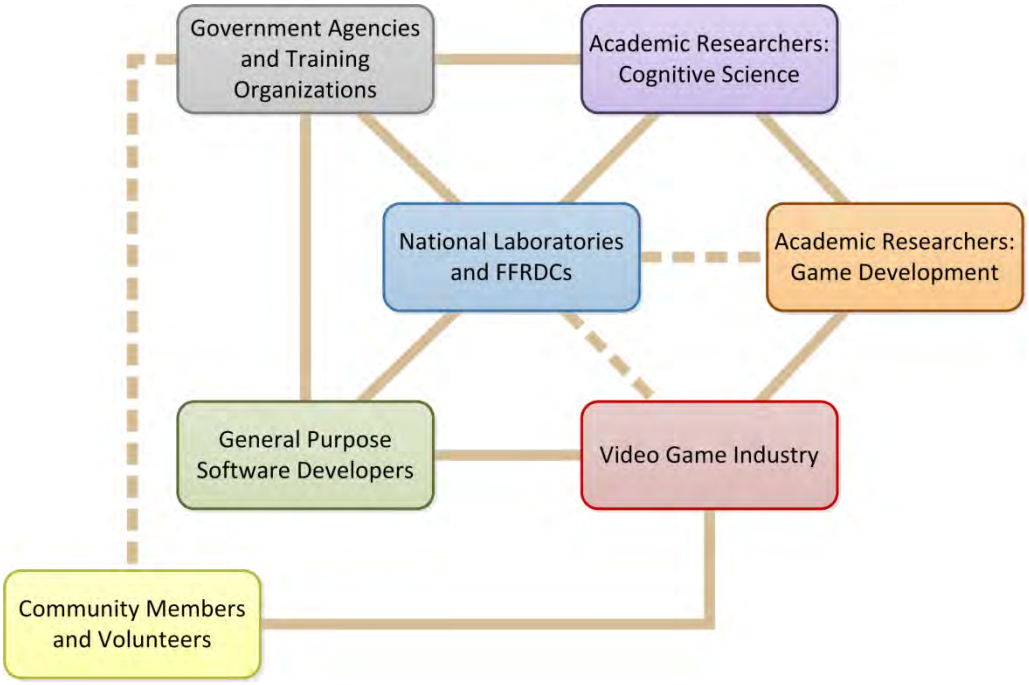

Figure 4. Traditional (solid) and emerging (dashed) collaborations between potential contributors to a game-based training project.

Figure 4 summarizes how these groups have traditionally collaborated and what potential and emerging collaborations would support the creation of game-based training materials.

- Government agencies and national laboratories have a history of working with each other, with academic researcher teams, and with general-purpose software development companies. However, neither has a history of working closely with game development academics or the video game industry, both of which can be strong partners in the creation of game-based training materials. National laboratories are likely to be a portal for bridging that gap, which calls for building stronger ties (dashed lines on the right side of the diagram) to those potential partners.

- Academic game degree programs and commercial video game companies are not entirely disconnected from government agencies at present. They already have indirect ties that can be leveraged to help forge more direct ties. As indicated in Figure 4, video game companies already work closely with general-purpose software developers, and academic game degree programs are often closely linked to academic cognitive science departments. Creating more direct links (indicated by the dashed lines) will be important, and it is a goal that is achievable in the near term.

- The video game industry also has a successful record of creating environments where their fans contribute creative content using their own time (as shown by the solid line at the bottom of Figure 4), which is a level of community engagement that government training organizations could benefit from emulating (as shown by the far left dashed line in Figure 4). Engaging game-based training with tools to support user-created content (e.g., custom scenarios and situations for an existing training game) could help to leverage existing talent in the emergency response community toward the creation of training materials.

4. MATCHING ORGANIZATIONS TO TASKS

The key tasks and organizations described in Sections 2 and 3 can be matched together in a range of combinations. The tasks will be completed more effectively if there is a well-structured collaboration between the organizations involved. Figure 5 shows which organizations are likely to be effective at filling each of the tasks.

Rather than rate the appropriateness on a traditional strong/moderate/weak scale, we have opted to categorize them on the role they would likely play in a collaboration – leading or supporting the task. Note that "supporter" is not considered to be a weaker role than "leader," but merely a different one. The leader may provide the primary guidance and strategic vision, while the supporter may provide the bulk of the labor and content to accomplish that vision.

Along with the seven roles described earlier, we have included the role of "process coordinator." Coordinating diverse communities such as the games industry and government training organizations is entirely possible, but it will require thought and care in how to organize and sustain healthy and mutually beneficial collaborations. In more traditional fields, the government sponsor or an academic expert might be sufficient to lead that effort. In the area of serious games, those actors have an important part to play, but the leadership should come from a third party with experience in both the application domain and in the field of serious game design.

	Analysis of Needs	Game Design & Prototype	Development	Scenario Creation	Validation	Curriculum Integration	Hosting and Distribution	Process Coordination
Government Agencies and Training Organizations	lead	n/a	n/a	lead	support	lead	lead	support
National Laboratories and FFRDCs	lead	lead	n/a	support	lead	support	n/a	lead
Academic Researchers: Cognitive Science	lead	n/a	n/a	support	lead	support	n/a	support
Academic Researchers: Game Development	n/a	support	support	support	n/a	support	n/a	support
Video Game Industry	n/a	lead	lead	support	n/a	n/a	support	n/a
General Purpose Software Developers	n/a	n/a	support	n/a	n/a	n/a	lead	n/a
Community Members and Volunteers	support	support	support	lead	support	support	n/a	n/a

Figure 5. The tasks each type of organization is suited to lead and support in the development of digital training simulations.

Identifying a set of actors who fill the necessary gaps is a start, but it is not sufficient to build a successful collaboration. For example, Government Agencies and Training Organizations, National Laboratories and FFRDCs, and the Video Game Industry (the first, second, and fifth rows) can either lead or support all the required tasks (represented by the columns), but identifying those contributors is only part of building an effective collaboration. It is also important to understand the structure of their collaboration, and ensure that the structure leverages each group's strengths and accommodates their weaknesses.

One of the main obstacles is that many of these organizations have very different modes of operation and different goals; as a result, they are all not familiar with how the other types of organizations operate. For example, building collaboration of independent game developers operating with little or no management overhead and shoestring budgets with a government organization with bureaucratic processes and low risk tolerance is not straightforward. Those organizations have a lot to offer each other, but they traditionally operate in very different fashions. Forging an alliance between them will require thinking about new or modified models for collaboration.

Another challenge in creating appropriate collaboration models is that game design is iterative. Like other user-facing products, creating an effective game (be it for entertainment or training purposes) is fundamentally an iterative process and rarely follows a linear design path. If forced into a traditional sole-source sponsorship model, game-based training tools are likely to suffer – they will be more likely to fail outright or to end up as successes only on paper, with limited real impact. However, with a model supporting iteration, those risks can be greatly mitigated. The program structure of game design requires support for multiple contributors, collaboration, feedback loops, and an acceptance that the shape of the final product may not be known up front. These are properties that can be unfamiliar to government sponsors, and may require some acclimation on the part of the sponsoring agency overseeing the work. However, iterative design is widely accepted in industry and there is precedent for government agencies successfully using "agile methods" to manage projects [6]. That trend extends far beyond just the creation of games, and the collaboration models we describe in this document may also apply more broadly than just to game-based training.

While game design has inherent uncertainty due to the reasons mentioned, there are models for collaboration that can reduce the risk. Examples of those models include leveraging experts in the field, using ongoing collaborative feedback mechanisms, and spreading risk over a wide range of contributors. While these models may not follow the traditional path, a closer look shows that most of them are analogous to conventional project structures, with adaptations for some of the unique properties of game design. For example, a game competition is similar to a Defense Advanced Research Projects Agency (DARPA) challenge or competitive bidding process, and a capstone project is similar to engaging a center of excellence or funding an academic conference.

5. COLLABORATION MODELS

This section describes how to foster, motivate, and direct the collaboration between the diverse set of contributors to reduce programmatic risk and increase the ultimate impact of the resulting product. It is important to understand that there is more to a collaboration model than just identifying who does what job. The structure of the collaboration, namely, how information is shared and how work is distributed amongst the collaborators, is a critical part of the equation, and such structures must be selected to suit the project goals and types of collaborators involved.

We have assessed seven collaboration models, each of which has potential variations. Some of these models can be combined to create hybrid approaches in order to mix and match models for different phases of the project; as a result, they should not be considered mutually exclusive options. We will examine the following models:

A. Traditional Project Sponsorship

B. Game Design Competition

C. Project Bidding and Development Platform

D. Academic Capstone Project

E. Commercial Dual Release

F. Special Game Mode

G. Center of Excellence

5.1 MODEL A. TRADITIONAL PROJECT SPONSORSHIP

A traditional project sponsorship model closely emulates a familiar path for many government agencies, involving a mostly linear development cycle with a carefully selected sole performer completing each task.

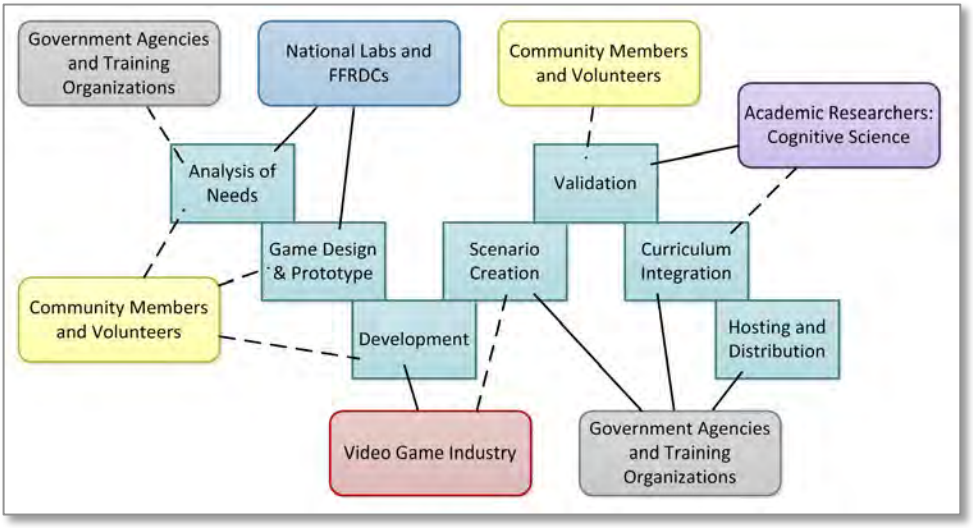

Figure 6. An example implementation of the Traditional Project Sponsorship model.

Figure 6 shows an example implementation of this model. The sponsoring agency and relevant subject matter experts (SMEs) support a national laboratory to assess the training needs. The laboratory then creates a game-based training prototype to meet that need. The prototype step reduces risk by allowing for lightweight design iterations and several rounds of feedback from SMEs to refine the game design prior to a larger development effort. The full development effort is then handed off to a single-source performer from private industry (e.g., a software development company from the video game industry). That company creates the production quality game and then supports a government training organization in adding scenarios and other domain-specific content into that framework. Academic researchers validate the effectiveness of the end product and, based on their findings, support effective integration into a training curriculum. In the long term, the government training organization hosts and distributes the game as part of a training or assessment program.

This model is very close to typical government program structures, with some important adjustments that make it effective for game-based training. SMEs are not just involved in the identification of the training goal or need; they are also actively included in the prototyping and development efforts, serving as play testers in a highly iterative process. The sponsoring agency will need to ensure that SMEs are made available to the performers throughout the process. There is an explicit validation step to confirm that the final product fills the needs identified earlier in the process. The leader of the validation step should be separate from the leaders of the design and development steps, to remove potential bias. In the depicted version, that means using an academic research team separate from the national laboratory involved earlier in the process.

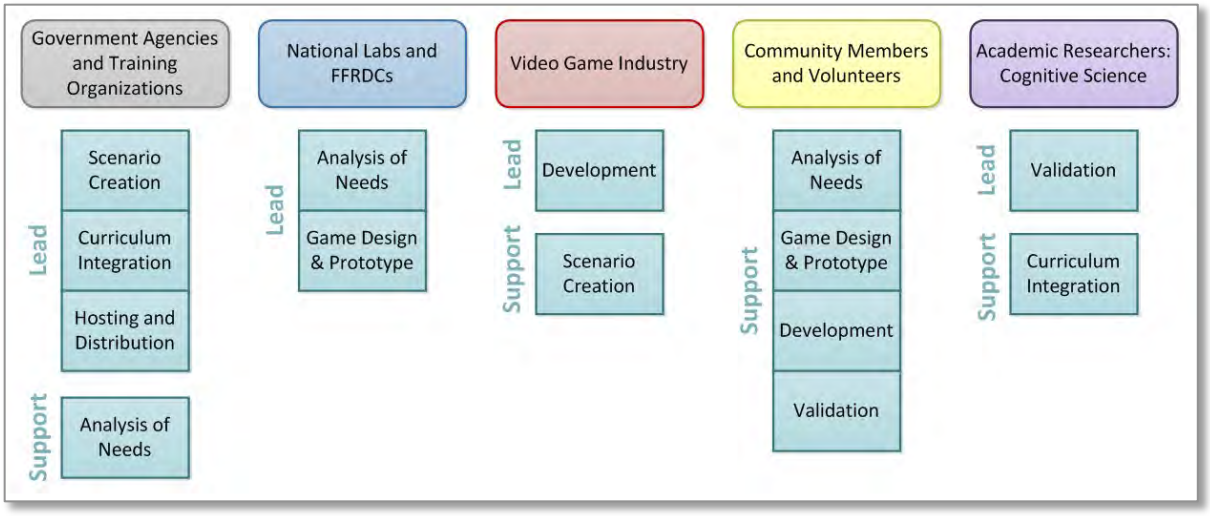

Figure 7. The roles each contributor might play under a Traditional Project Sponsorship type of collaboration.

5.1.1 Strengths and Weaknesses

A traditional project sponsorship model works best when the techniques and technologies involved are already well understood, so that a design can be selected and frozen up front. The adaptations described earlier help to inject some of the iterative development cycles necessary to game development. A single performer following a requirements document as a legal contract will reliably produce a functioning product that meets the design, but may not actually meet the original need. As the field of game-based training matures, this approach may become more viable, but in the current state, it should be used sparingly, and alternatives should be considered, if viable, in the political climate of the sponsoring agency.

5.2 MODEL B. GAME DESIGN COMPETITION

A game design competition is, at its heart, a kind of broad agency announcement (BAA) process where the participants demonstrate their abilities and ideas as part of the bid. The project then benefits not only from seeing a wide range of ideas, but also from having more information about the abilities of the candidate performers. The structure may be familiar to both government sponsors (e.g., DARPA Urban Challenge, DARPA Robotics Challenge) and game developers (e.g., Global Game Jam, Game Jam Central), and thus be effective at bringing those communities together.

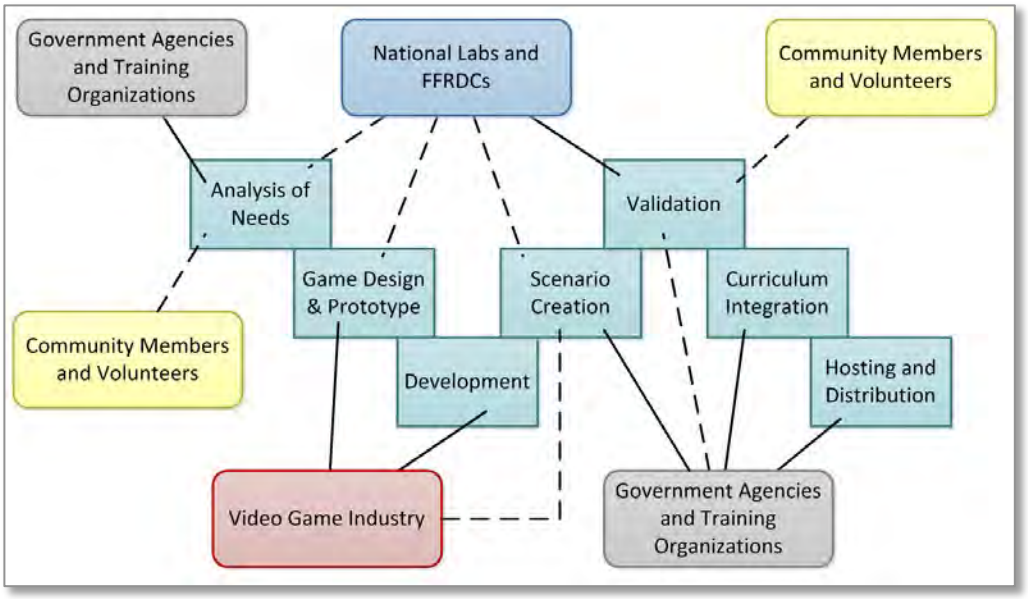

Figure 8. An example implementation of the Game Design Competition model.

Figure 8 illustrates a sample workflow for a game design competition. The process begins with an analysis of needs led by the interested government training agency. Rather than making an up-front decision on a single design to meet the identified needs, the statement of need is provided as a challenge for a game competition. Participants submit ideas and quick prototypes for games to meet those needs, and the best ones are selected for refinement over two to three rounds. As the contest proceeds, the rounds shift from being more about finding promising ideas to developing those ideas into working games. The finalist games are then augmented with scenarios and domain content provided by the training agencies that wrote the original statements of needs. Up to this point, a national laboratory phrases the analysis of needs in terms of a game challenge, judges the contests, provides guidance to teams, and helps adapt scenario needs to developed games. The national laboratory then takes a more active role in validating the resulting game-based training materials, before those materials are integrated into a training curriculum and hosted for ongoing use.

The process has many similarities to a traditional BAA bidding process. It is common for companies bidding for a high-stakes, software-based BAA to demonstrate their ability in the area with a simple mock-up or prototype of the capability required, both to win the bid and to help the government sponsor understand what capabilities already exist. For many independent developers, a contest with $50k in prize money would qualify as a high-stakes project and garner a similar level of investment and interest.

The Game Design Competition model differs from a traditional BAA by including the initial prototype into the bidding process, and offers consolation prizes for submissions that are not ultimately selected. However, the end result is very similar to a BAA and would produce comparable benefits for the government sponsor.

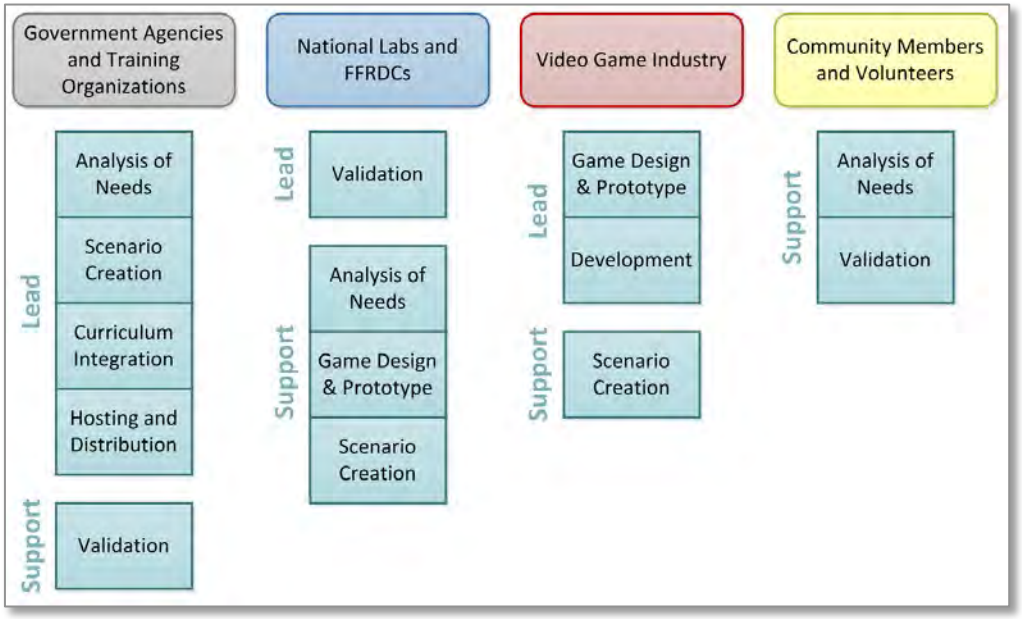

Figure 9. The roles each contributor might play under a Game Design Competition type of collaboration.

5.2.1 Strengths and Weaknesses

This model is particularly appealing in the area of game-based training, since there is a large community of independent game developers with strong creative and technical skills, available inexpensively, and often strongly motivated to make a positive impact on the world. This community is very familiar with the notion of a game jam (a short time-frame game design competition), so such a structure could be an inexpensive way to leverage an experienced talent pool – a prize pool of $50k or less would attract top minds from the community and provide a large pool of ideas to select from, along with the talent to develop and mature those ideas. When overseen by an experienced national laboratory, the model can also be comfortable for the sponsoring government agency. The laboratory provides cohesion to the effort, keeps the participants focused on the project goals, helps the independent participants manage government bureaucracy, and serves as a single point of contact for the sponsoring agency.

Nevertheless, this model will feel unfamiliar to many sponsoring agencies. As with other iterative development processes, sponsoring agencies will need to acclimate to the notion of not knowing what the final product will look like even while development is underway, and instead trust that many iterations and expert feedback will keep the program on track.

5.3 MODEL C. PROJECT BIDDING AND DEVELOPMENT PLATFORM

A bidding platform aims to reduce the overhead of funding many small programs in an area by sharing overhead between those platforms. It would be appropriate when (or if) game-based training becomes more widespread and building infrastructure to support their development is cost effective.

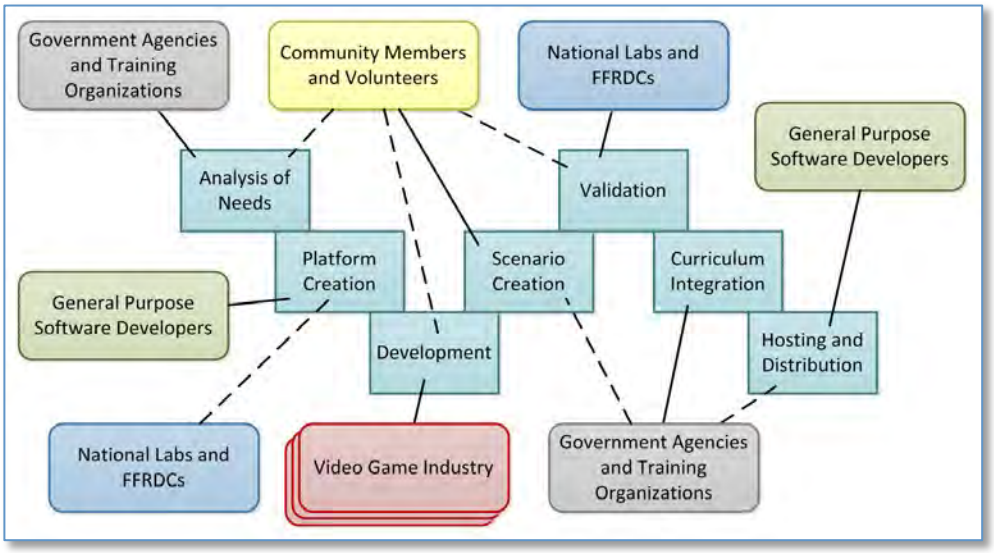

Figure 10. An example implementation of the Project Bidding and Development Platform model.

A possible work flow of this model is shown in Figure 10. An initial survey identifies commonalities among the typical needs of agencies with training needs suitable to game-based training. A general-purpose software contractor, with guidance from a national laboratory experienced with serious games, develops a platform providing tools, support, and bidding functionality. Then individual government agencies can advertise their needs on the platform and receive bids from developers in the video game industry. Bidders would be able to leverage provided common libraries such as models for how populations move during a disaster, weather models, game design templates, and art assets focused on emergency response. Scenarios for the games could also be crowdsourced via the platform, allowing professional first responders and emergency managers to provide content for existing game templates and designs. The resulting games, with their domain-specific scenarios, could be validated and integrated into training programs. The platform would also provide basic hosting services, so that individual government training organizations would not need those skills in-house.

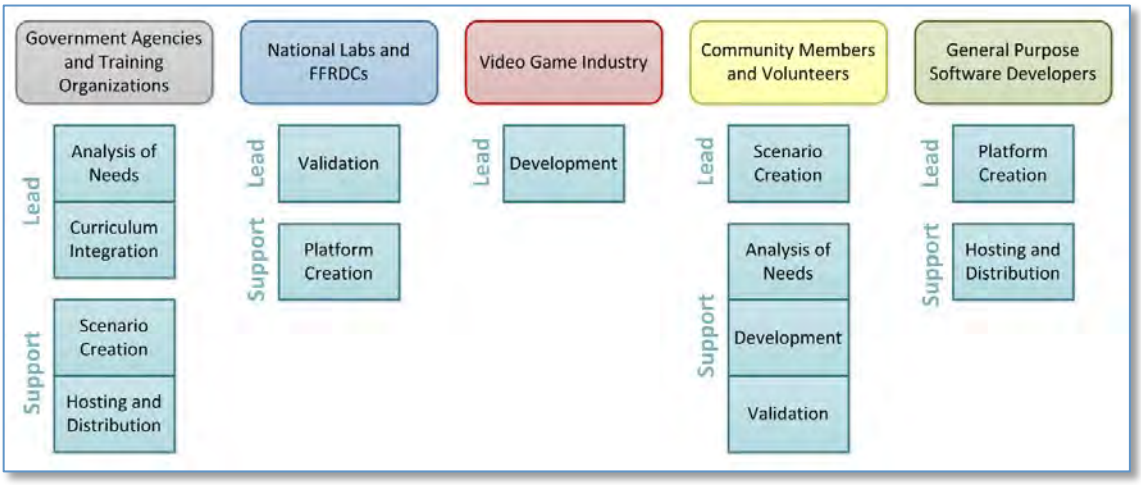

Figure 11. The roles each contributor might play under a Project Bidding and Development Platform type of collaboration.

5.3.1 Strengths and Weaknesses

A project bidding platform can be an effective tool for lowering the overhead cost for funding small projects in a field. Tracking ratings and reputation for performers would reduce risk of the government agency requesting bids, and allow them to access talented, low-cost freelance labor. However, this model requires critical mass of supply and demand for game-based training to justify the cost of maintaining the platform and to attract enough attention from the games industry to quickly meet calls for bids. However, once sufficient interest from both sides exists, a bidding platform could greatly reduce the time and dollar cost of creating training materials.

5.4 MODEL D. ACADEMIC CAPSTONE PROJECT

Academic capstone projects are common in engineering programs as a means of giving students experience working as a team on an end-to-end project. The general goal of capstone projects is to provide practical experience to students prior to graduation. As demonstrated by the Beaver Works program [7], students can also be leveraged to meet government needs, which assists the participating agency and provides the students a more realistic and fulfilling educational experience. This model could be most applicable to universities with academic game degree programs where students are trained to design and develop video games.

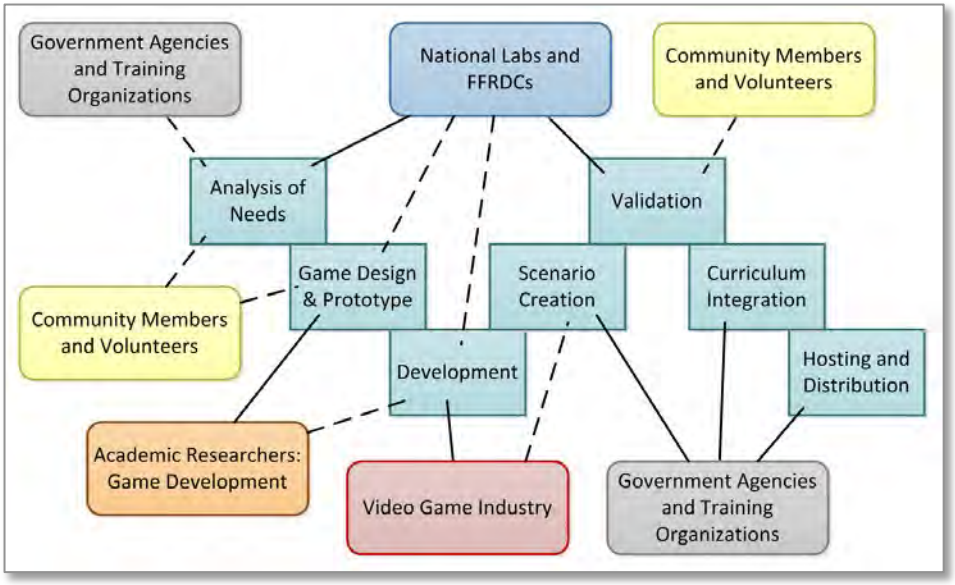

Figure 12. An example implementation of the Academic Capstone Project model.

One way to organize such a program is shown in Figure 12. A national laboratory leads the assessment of needs, and then continues to coordinate and support the subsequent steps. The needs assessment is provided as a capstone project goal to senior-level students in an academic game degree program, who then prototype the game with feedback from SMEs. Depending on the nature of the program, the capstone students might also be involved in the analysis of needs to help them build domain analysis skills and better understand the needs of their users. The final projects are then handed to a professional development company for production quality development and to support the addition of custom scenarios. The national laboratory completes its role by validating the final product in preparation for curriculum integration and hosting.

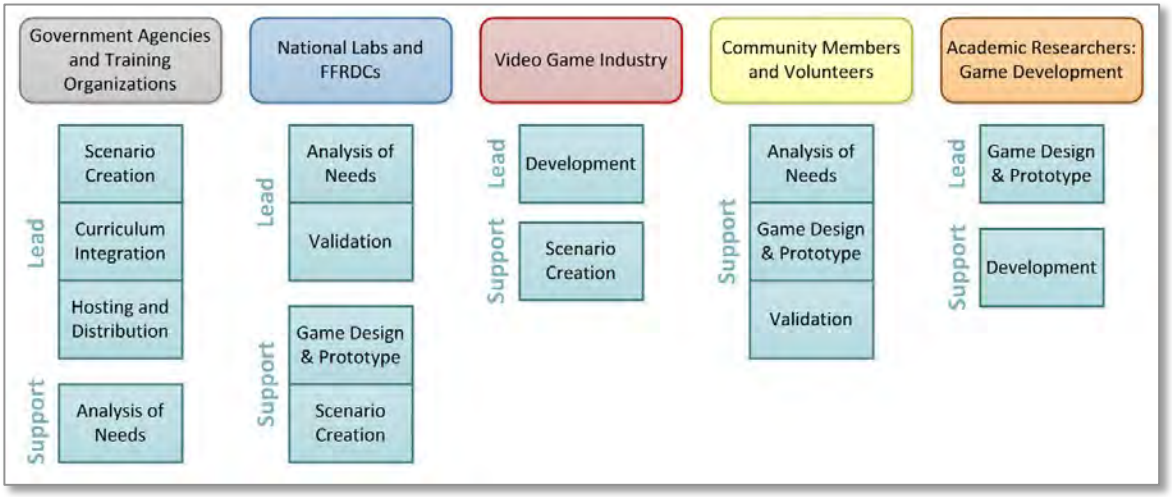

Figure 13. The roles each contributor might play under an Academic Capstone Project type of collaboration.

5.4.1 Strengths and Weaknesses

Leveraging students in this manner is a very inexpensive way to access top talent and fresh ideas. It also serves to direct the attention of young professionals toward the needs and issues of the participating government agency. This model may be best used as a precursor and supplement to another model – in the diagrams above, it can be seen pairing with a traditional project sponsorship (Model A).

5.5 MODEL E. COMMERCIAL DUAL RELEASE

A commercial dual release is when a private company receives partial funding for creating a product family that includes both a commercial for-profit version and a version delivered to the government sponsor to be used as a training tool. This technique that has been leveraged by past Department of Defense (DoD) programs [8, 9].

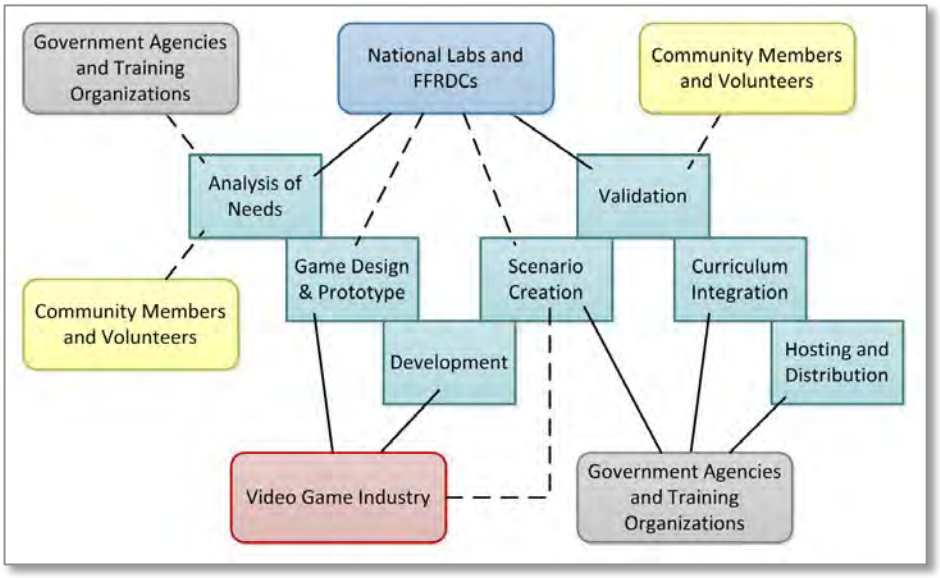

Figure 14. An example implementation of the Commercial Dual Release model.

Figure 14 shows how such a collaboration might unfold. A national laboratory helps identify an area of need that aligns with popular video game styles and helps guide a commercial company in building such a game. The private company designs and develops the game and helps the government training organization build scenarios for it. The government then takes one version of the game as government off-the-shelf (GOTS) software and validates, integrates, and hosts it. The commercial partner takes a different version of the same game and releases it as a commercial product.

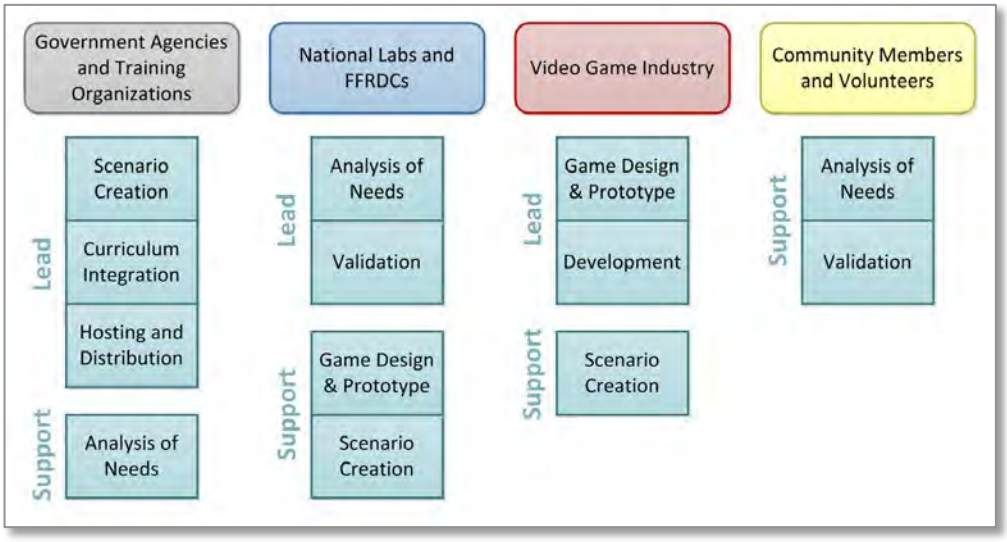

Figure 15. The roles each contributor might play under a Commercial Dual Release type of collaboration.

5.5.1 Strengths and Weaknesses

When this model works, it can be a big win for both parties. The government gets training materials at a greatly reduced price, and the commercial partner gains a long-term revenue stream with little up-front investment. However, there are two important challenges in making the model work.

Challenge 1: Alignment of Interests

It is hard to find opportunities where training and entertainment interests are sufficiently aligned. The successes in the DoD were based on squad-level tactics where realism of the commercial product was a selling point, and the general domain (modern tactical shooters) had a history of commercial viability. Making such a model work for a non-militarized domain such as emergency management or first response is a challenge, but not an impossible one. For example, the recent popularity of the "survival" genre of entertainment game may be a point of common interest; players attempt to survive as long as possible in a hostile environment by foraging and evading threats, rather than violent confrontation of the threats. Such a game might serve to train the public or learn how the public responds to different situations.

Another variation of this approach is to create a shared game engine rather than a shared game. The partners share the costs of developing the core technology, but then diverge in which scenarios and settings are recreated with that technology. Many of the skills that can be effectively trained with game-based techniques are strategic skills and soft skills. Those skills are commonly part of successful entertainment games, and an effective training tool might become a commercially viable product simply by recasting it in a different setting. For example, a game about making hard resource allocation decisions in the aftermath of an earthquake might translate to space travelers attempting to survive the rigors of an alien planet. Both games could use the same underlying game engine and technology, but be presented with different art assets and supporting game mechanics.

Challenge 2: Managing Publicity

In the case of Full Spectrum Warrior (released circa 2004), a DoD program manager funded a commercial company to create a dual release game, as a means of creating a game to train small squad tactics. Both parties benefited financially but suffered forms of political backlash [10]. The government was criticized for funding a game that was later sold by a private company for profit. The fact that the agreement saved taxpayer dollars did not abate the criticism. On the other side, there were reports of controversy within the company that developed the game, as many managers felt that the company should not be prioritizing the creation of a version of a game that they couldn't sell (the training version of their commercial product). The fact that they received vital funding in advance to support the additional development costs did not remove the controversy. In summary, there are social and political considerations that go along with the potential benefits in cost and quality.

Overall, this technique cannot be reliably depended upon, as there may simply be no commercial partner interested in making a similar commercial release. When such opportunities are found, both sides can potentially benefit greatly, but even then there is risk of a backlash. In conclusion, it is worth watching for opportunities to leverage this model but it should not be relied on or pursued without careful consideration.

5.6 MODEL F. SPECIAL GAME MODE

Creating a special game mode is an approach that leverages existing commercial games for game-based training purposes, by identifying such games that already have affordance for representing strategic choices, procedural rehearsal, or narrative immersion relevant to the objectives and training skills that the government agency is looking for.

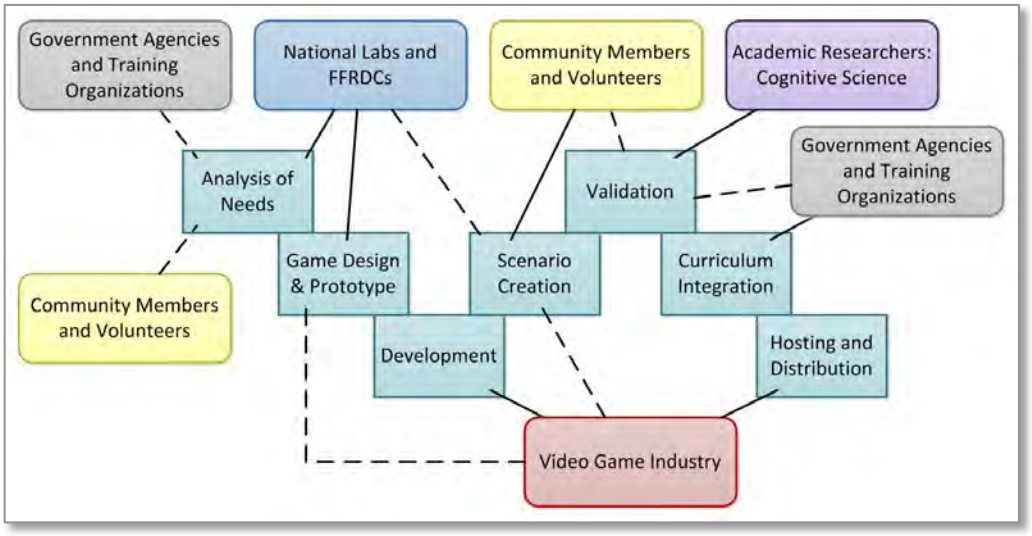

Figure 16. An example implementation of the Special Game Mode model.

The flow of a special game mode project is shown in Figure 16. A national laboratory assesses current training needs that might be captured by or embedded into existing commercial games. They work with the developer of that game to design a special game mode to target those needs. The developer takes over the polished implementation of that mode and then supports SMEs and existing players of the commercial game to flesh out the scenario content for that game mode. An academic research team validates that the special game mode serves the training need, and then the training organization integrates it into a training curriculum. The original developer hosts the special mode using their existing infrastructure.

This model could be similar to a Commercial Dual Release (Model E); the game mode created might have commercial value to the developer. However, even if the special game mode is only of value for training, reusing an existing and established game can greatly reduce development costs (since many iterations have already been put into the commercial game), increase the engagement of the product (since the product has already been tested in a competitive market), and increase the chance that the training effectiveness will be validated (since we can identify games that have already demonstrated the ability to capture difficult strategic choices, provide narrative immersion, or drive players to rehearse best practices).

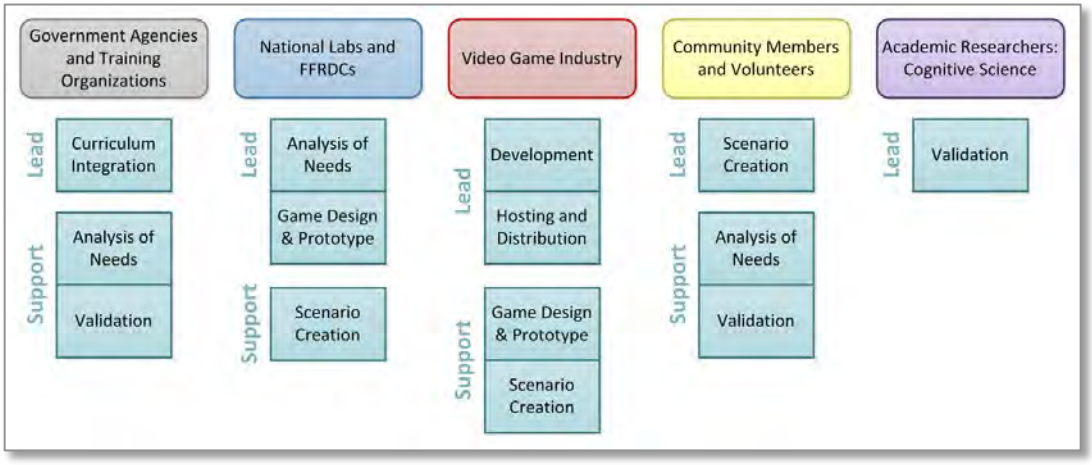

Figure 17. The roles each contributor might play under a Special Game Mode type of collaboration.

5.6.1 Examples

The Gates Foundation funded an add-on to SimCity for learning [11]. Consider a few other potential special game modes that could leverage popular games to target relevant skills and decisions:

- A multiplayer online battle arena (MOBA) such as League of Legends, DOTA 2, or Heroes of the Storm could have a mode in which human players only play support roles, and all other champions are controlled through artificial intelligence (AI). Support roles in those games generally focus on collaboration, empathy, and strategic awareness, while other roles focus more on raw execution skill.

- A real-time strategy game (RTS) such as StarCraft or Red Alert could be modified to target specific resource allocation skills and time management.

- A large-scale calamity could be injected into a massive multiplayer online (MMO) game such as Eve Online, allowing observations about how different incentives and environments create or undermine collaboration by survivors.

- Extensions to SimCity could be created to focus on more realistic disaster preparation, response, and reconstruction.

- A narrative game could be created to focus on the moral dilemmas faced by survivors of a terrorist attack as they balance their own safety against the opportunity to help others.

5.6.2 Strengths and Weaknesses

A special game mode requires identifying an opportunity for overlap between an existing game and a training need. While this model has many appealing features when it is possible, sometimes it will simply not be an option. It is worth noting that the types of skills for which game-based training is

particularly effective (strategy, teamwork, narrative immersion) are skills that commonly appear in successful entertainment games. Consequently, reusing an existing product provides several clear advantages. Much of the software already exists and has been well tested, the skills tested by the game are likely to be well understood in fan analysis of the game, and there is already an existing player base that could be leveraged to help test and refine new game modes. Fans of a successful game are likely to be independently motivated to see their favorite game serve a public good, and thus are likely to effectively volunteer their time to help refine new game modes. Furthermore, some applications of game-based training are intended to train the public, in which case the existing player base is especially important, as they can help overcome the major hurdle of bringing training efforts to the public's attention.

Perhaps the biggest weakness of this model is one of acceptance. In organizations that currently have a stigma against games used as tools for training, reusing a game that was never intended to be serious could be a significant barrier. Even if the opportunity is there, the culture of the sponsoring agency may not be willing to pursue it.

5.7 MODEL G. CENTER OF EXCELLENCE

The proposed collaboration models all have strengths and weaknesses, so picking the right model for a given agency or a particular project is a skilled task unto itself. Rather than leave these difficult tradeoffs to the sponsoring agency, they could be placed in the hands of a new center of excellence in game-based training. Such a center might be structured as an FFRDC, an academic center of excellence, or part of a government training agency. The center would be a lasting repository of knowledge and infrastructure for making game-based training effective, thereby removing the need for individual government agencies to relearn and redevelop those skills and tools on each project.

Justifying a center of excellence would require a certain critical mass of interest in serious games, but it may be achievable in the near term by leveraging existing laboratories with serious games experience and existing university programs in game development and modernized educational techniques.

6. SELECTING THE BEST MODEL

The seven models we have discussed all have different strengths and weaknesses. We have already eliminated from the list any models that we categorically advise against; there is no clear winner for all projects and all sponsoring agencies. However, for a given project in a given agency, some models will be vastly more effective than others. For example, the traditional project sponsorship (Model A) might be the best method for creating additional scenarios for an existing training program, but a game competition (Model B) might be more effective at creating materials to target newly identified needs and gaps. Academic capstone projects (Model D) might be a good model for agencies new to game-based training but familiar with sponsoring research, whereas a commercial dual release (Model E) or a special game mode (Model F) might be effective models for agencies more comfortable and experienced with the use of game-based training. A game measuring strategic skills might require more careful oversight (Model A or E) whereas a game about narrative immersion might benefit greatly from drawing on a wide range of new talent (Model B or D).

Figure 18 summarizes the characteristics of each model, and compares them to existing successful models in both government and non-government sectors. The rest of this section provides further information on the model comparison relative to each characteristic (represented by the columns in Figure 18). The goal of this section is to provide the reader with a starting point on the types of topics to consider when choosing an appropriate collaboration model for creating game-based training tools.

Model		Approx. Project Budget	Initial Setup	Availability of Opportunities	Likelihood of Impact	Product Maturity	Similar Government Structures	Commercial Precedent
A	**Traditional Project Sponsorship**	$500k-10M	None	On Demand	Low - Med	High	Sole Source Project	Mission US, Mindset Quest, Triad Interactive
B	**Game Design Competition**	$100k-200k	None	On Demand	Med - High	Med	DARPA Challenge, BAA	Global Game Jam, Game Jam Central, IndieGameJams.com
C	**Project Bidding and Development Platform**	$10k-100k	Required	On Demand	Low - Med	Med	BAA	ArtCorgi, Bricklink, Upwork, Toptal, Shapeways
D	**Academic Capstone**	$10k-100k	Required	On Demand	Low - Med	Low	Existing Centers of Excellence	MIT Beaverworks, NASA Glenn Research Center
E	**Commerical Dual Release**	$1M-10M	None	Require Opportunity	Med	High	Sole Source Project	Full Spectrum Warrior, America's Army, NumberShire, Sokikom
F	**Special Game Mode**	$100k-1M	None	Require Opportunity	Med	High	Sole Source Project	League of Legends, Plants vs. Zombies 2, Quake, Portal 2
G	**Center of Excellence**	$100k-10M (varies by sub-model)	Required	On Demand	High	Med	Existing Centers of Excellence, FFRDCs	MassDigi, CIGG

Figure 18. Comparison of the strengths and weaknesses of the seven collaboration models. The final two columns compare these models to structures that are tried and true in both government and non-government sectors.

6.1 APPROXIMATE PROJECT BUDGET

Similar to other software projects, the budget required to create a game varies greatly with the intended scope. However, the collaboration models also play a big factor. Some collaboration models only work for large-scale projects while others only work for less complex projects, so selecting the best model depends partly on the expected scale of the program budget.

Traditional project sponsorship (Model A) involves a lot of overhead and oversight – elements that reduce risk and avoid corruption, but also increase cost. Large programs can absorb such costs, but smaller programs can be overwhelmed by them, making small lightweight projects impossible in that environment. Such projects generally select a larger company with the administrative maturity to manage government bureaucracy and traceability, which also drives up the cost of the final project.

In contrast, structures like a game competition (Model B) can use a relatively small amount of funds to gain a large range of ideas from independent developers and fund only the best design through production; see Appendix B for sample figures of how such a program could be structured. By working with independent developers, the cost drops considerably. Of course, there are other drawbacks, such as lower product maturity, which are captured in Figure 18.

6.2 INITIAL SETUP

While individual projects may have a wide range of costs, some of the suggested collaboration models require additional infrastructure to be provided up front before any projects can be pursued under that model.

For example, a bidding platform (Model C) may have low costs per project, but it requires the creation and maintenance of the platform for managing bids and tracking ratings for performers. Similarly, creating an individual capstone project (Model D) can be nearly free, apart from a small level of supervision, but such a program requires a commitment on the part of the collaborating university that likely comes with up-front costs for helping them to design their program to align with government needs.

Using an existing center of excellence (Model G) for managing game-based training might minimize setup costs (in comparison, for example, to creating an entirely new center), but even an existing center can have costs outside of the individual projects – for a center of excellence to be effective, it needs to have an active repository of experience and talent, which may involve gap funding to carry the center along between programs, or provisions to allow them alternative sources of funding beyond government programs.

In contrast, the other models can be run on a per-project basis. While the cost may be high for a traditional project model (Model A) or a dual release commercial project (Model E), that cost is limited to the individual programs. No outside infrastructure (neither organizational nor technological) is required to enable such programs.

6.3 AVAILABILITY OF OPPORTUNITIES

Some models can be executed whenever there is a demand for them. Others require finding a suitable opportunity, but the availability of such opportunities cannot be fully predicted. This limitation

applies most strongly to the models that rely on leveraging commercial products that are similar to the domain or skills being targeted, either the creation of a new product (via a dual release) or modification of an existing one (via a special game mode). This limitation is not to say that those opportunities are rare; they may, in fact, be common. However, regardless of their frequency, they represent an element of uncertainty that can limit the use of the model.

The other models are largely free of such limitations. Even the bidding platform (Model C) can avoid any such issue. The software freelance and independent developer communities have a large supply of skilled workers who are willing and able to meet the requests made on a bidding platform. Even if the platform is only lightly used and thus is only providing nominal income to the developers serving it, it is likely to have a responsive community. Similar platforms for other low-salary industries (such as artists) have a track record of providing responsive service, even when they are only serving as supplemental income for the participants. They may be unreliable for suppliers of the products, but they are typically very reliable for customers. In the case of capturing independent game developers, the government would benefit as a customer receiving reliable service.

6.4 LIKELIHOOD OF IMPACT

Many factors aside from the collaboration model contribute to whether or not a program ultimately has a positive impact, and all programs carry risk of falling short. However, some models mitigate that risk more than others. This risk is not referring to the risk of fraud or deception on the part of the performer, but rather the likelihood that the product will actually solve the customer's problem. It is all too common for a developer to provide the exact product requested, only for the buyer to later discover that their request was not quite what they wanted.

There are two big factors in the likelihood that a product will fail to solve the customer's problem despite meeting its legal specifications:

- the number of design alternatives assessed, and
- the creative freedom and motivation of the performer.

These factors are even more important in user-facing software such as games and game-based training materials.

A traditional project sponsorship (Model A) typically suffers on both accounts. It quickly narrows the design space down to a single option, without iterating on alternative designs, and it provides a legally binding requirements document that limits the freedom of the performer to modify the design as development proceeds. Those are often necessary costs to minimize opportunities for corruption and fraud, but they are still very real costs.

A project bidding platform (Model C) suffers similar problems. In order for developers to bid on a project request, they need to know the detailed design of that project and the expectations of the buyer. However, by providing that information up front and then selecting a bidder, the project has already added a risk that the project will fail to meet their true needs.

A game design competition (Model B) rates fairly well. The independent development community has a reputation for self-motivated talent and any underperformers are easily rooted out in a competition with enough participants. A relatively small prize pool can motivate a large number of participants to contribute ideas and prototypes, allow the customer a wide range of options, allow those options to be partially developed, and be very selective about which ideas are pursued to completion. Between a high number of design alternatives and developers with creative freedom, there is an increased chance that the final design will be effective and impactful.

Academic capstone projects (Model D) do not rate as well, despite superficial similarities to a game design competition. While students are likely to have many ideas, they lack the experience and wisdom to vet those ideas themselves. So, while there will be a larger number of ideas produced, there will likely be a lower number of good ones. While capstone projects are inexpensive and may produce good ideas, they will never be as reliable as professionals, even independent professionals.

Keep in mind that while these models differ in their chance of success, all of them are reasonable to consider. Models that would usually produce an unusable product have already been omitted from the list. The ratings are relative, and benefits in other columns (such as cost, maturity, or opportunity) may make up for a deficiency in this one.

6.5 PRODUCT MATURITY

We distinguish the likelihood of impact from the maturity, stability, and professionalism of the product itself. The quality of the product, when it does succeed, is largely a function of the experience of the performer. Amateurs (such as students) will produce rough (albeit usually functional) products, small-scale professionals will produce solid products (such as independent developers in a game competition or freelance software developers using a bidding platform), and the best products will come from developers with a proven track record.

6.6 SIMILAR GOVERNMENT STRUCTURES

Some of the models may appear novel or unusual for a government-sponsored project, but they all have analogs with long and reputable histories. Traditional sponsorship, commercial dual releases, and special game modes are really just variations of sole-source projects. They offer different means of reducing the cost, encouraging creative freedom, or leveraging existing user bases and infrastructure, but they do not fundamentally differ from most government-sponsored projects.

Game design competitions and bidding platforms have a history in DARPA challenges and are essentially variations of traditional BAA models. They are tailored to capture talent from the games industry, but would unfold in a manner familiar to many government agencies.

Academic capstone projects and creating new centers of excellence are similar to existing models where government agencies fund academic centers of excellence, FFRDCs, and research conferences to create communities, improve research, and direct industry toward problems relevant to that agency. Those approaches are certainly well suited for agencies with a research focus, but they can also be very effective tools for risk reduction and coming up with fresh ideas for projects that aim simply to produce a useful product.

APPENDIX A. SERIOUS GAMES FOCUS GROUP NOTES

On August 27, 2015, MIT Lincoln Laboratory hosted a focus group about serious games at Beaver Works on MIT Campus in Cambridge, MA. The group focused on overcoming practical and organizational barriers to collaboration between government organizations with existing or emerging interest in serious games and nongovernment organizations that might be able to support those efforts. There were over 25 attendees from a range of organizations interested in serious games, representing multiple organizations from each of the following economic sectors:

- **Government agencies**, including both project managers and Incident Management Assistance Teams (IMATs),
- **National laboratories**, including multiple FFRDCs,
- **Academic institutions**, including both game development degree programs and cognitive science researchers, and
- **Video game–related private companies**, including large companies, independent developers, and nonprofit research-based firms.

The working group was organized around a mixture of full group discussions and breakout sessions; each breakout group contained four to six attendees spanning all four economic sectors.

The information captured in this appendix supports and elaborates on the ideas of the main document. It serves both as corroborating evidence, and as suggestions of future directions for extending these ideas. Each paragraph in the rest of this appendix is attributed to an economic sector; indicating the background of the attendees who contributed the idea. Additional citations and explanation have been added by the authors of this document to substantiate statements made by the attendees, but the ideas described in this appendix were generated by attendees not the authors. These comments have been reviewed with those attendees to ensure that they are accurate and authentic.

OPPORTUNITIES FOR IMPACT

Game-based training can be applied to a range of topics. Helping experienced tactical thinkers understand strategic tradeoffs and experience larger-scale dilemmas prior to an actual incident is valuable for supporting emergency managers as they rise in rank. Their on-the-job experience and traditional training methods serve them well in developing their tactical and procedural skills, but they often struggle when they advance to a position requiring a larger view of the situation. Strategic game-based techniques can bring those issues to the surface and help to directly address them [12]. <Source: Government>

Game-based methods can also be an effective and lower-cost method for targeting skills currently taught in the classroom or via a live exercise [13]. For example, one concern with live training and rehearsal is that human behavior can change in the presence of an observer, distorting assessments of readiness and preparation. In contrast, background monitoring of a digital exercise over multiple

iterations of a short scenario-based game can put people at ease, get a more accurate measurement, and provide more repetitions to improve retention. <Source: Government >

A valuable part of any educational tool is feedback. It is well accepted that shorter feedback cycles engage and train students more effectively in both entertainment and educational settings. The briefing after a live exercise can be just as valuable as the scenario itself, as it offers a chance to reflect and discuss decisions, mistakes, and triumphs just experienced. Game-based training offers an opportunity to make that feedback loop shorter (giving feedback as you play the game) and allow more iterations of the learning cycle (by playing a shorter training game several times in sequence). <Source: Academia>

Playing nominally one-player games as a group can drive a discussion that is informative and supportive for creating cohesive teams. Being forced to justify and explain a move, rather than just making it, can recreate valuable dynamics from real situations in the context of even very simple game-based training scenarios. <Source: Government>

Another part of training is emotionally understanding the people involved in an incident, including survivors, other agencies, and political figures. Games and interactive fiction have matured greatly over the past two decades in delivering narrative experiences that immerse the player and trigger empathy and emotion toward entirely fictional characters by drawing on techniques from film combined with involving the players themselves in the story. Narrative games could be leveraged to capture formative experiences of experienced professionals, and to crystalize and convey these to the next generation of responders in a way that sinks in and has a lasting impression. One attendee said, “For emergency response training, you want to create emotional attachment, so players feel the pain of hard choices and loss, but to still have a fictional environment they can later separate themselves to reflect and think strategically.” Games have proven their ability to do that, and narrative-style games should be added to the suite of tools used by professional trainers. <Source: Academia>

Another class of tools that could be of value to government agencies are public-facing games, with the goal of assessing public preparedness and predicting public response to scenarios of interest. For example, “survival” games are quite popular right now, involving unarmed players attempting to survive in hostile, and often quite realistic, environments. Data from such a game could reveal how people respond to novel situations, form collaborations, and react to public communication. A sequel to such a game, released just after a real world event, could also measure how the public responds differently when they are primed; e.g., add a forest fire module to a survival game after new coverage of forest fires or an educational campaign by FEMA. Even if the game is only played by a small sliver of the nation’s population, it could provide a valuable insight into what efforts and events change people’s behaviors. You could also correlate such behavior to other measures of the players’ personality archetypes, to better understand how to effectively provide guidance and education to different segments of the public. <Source: Industry>

GARNERING GOVERNMENT INTEREST

Despite a range of potential benefits (lightweight training, soft skill evaluation, expert knowledge transfer via interaction scenarios, strategic exploration), many parts of DHS and other government agencies hesitate to seriously consider serious games as tools to leverage. There is still a stigma against games as being “frivolous” or “unprofessional.” Such perceptions persist despite a long history of games

in DoD [14, 15, 16, 17] and active research showing their potential benefits [1, 3, 4]. While there are open research questions about the use of serious games, and when and how they can be effective, many of the obstacles are political and social not scientific or technical. However, there are a number of strategies to overcome such barriers. <Source: Government>

Continuing research on providing quantitative measurements of benefits can help remove political and social barriers. While traditional training techniques, such as classroom or online training, are often implemented based on best judgment of professionals, the newness of serious games puts them under greater scrutiny and requires stronger scientific validation. Measuring educational outcomes, especially in the area of soft skills and strategic skills, has always been difficult, but other types of validations can help build confidence. For example, game-based training validation could benefit from more work in the areas of knowledge retention studies, informal self-reports from students and instructors, tracking time voluntarily spent with the training materials, and measuring types of conversations generated within teams. <Source: National Laboratory>

Terminology matters a lot. A method called a "serious game" might appear unprofessional, whereas the same method labeled as "virtual training," "modernized training," or "digital exercises" might be accepted. Similarly, analogies between training methods and video games might be intimidating to users who are not computer savvy, whereas the same users likely have smartphones and would be quite comfortable with the same material labeled as an "app." Overcoming first-impression biases can be an important part of gaining traction. <Source: Government>

It is often difficult to convince people that a Chemical Biological Radiological Nuclear Explosive (CBRNE) event is an important/hard problem when an incident has never occurred or when the incidents are very rare. Lower-cost techniques for preparation, such as game-based training, could interest local branches with many pressures on their time. National FEMA operates to support the regions; if the regional coordinator can demonstrate need (including data to support skill transfer effectiveness), National FEMA can provide resources to do so and will be much more amenable to newer techniques such as game-based training. Collaborations with local and regional agencies also provide opportunities to continue the kind of validation research that is important to mature the field. Local and regional agencies could track student feedback and impact on retention after integrating game-based learning into classroom and online training courses. <Source: Government>

In fact, regardless of the method employed (game-based or otherwise), training organizations will need to improve their understanding of the targeted soft skills. For example, game-based and other modernized training methods will rely on clarifying the following elements:

- How do we identify a set of skills relevant to a particular community or position?
- How do we evaluate or test the presence of a skill?
- How do we train an emergency manager to move from one position to the next (e.g., from regional to national)?
- How do we ensure that skills transfer from the training to job competence?

Without well-understood and objective measurements of job performance, it is difficult to properly validate or assess any training method, game-based or otherwise. It is unrealistic to expect such standards to emerge in the near future, so alternative approaches should be investigated, such as informal SME validation of game-based training materials rather than formal scientific validation. <Source: Government>

Many government sponsors are less worried about carefully validating skill transfer and more worried about whether the users (i.e., trainers, management, students) will accept the game, and if it will be built in a way that draws on relevant domain expertise and is cognizant of the target students' needs. <Source: National Laboratory, Government>

Initially, it might be prudent to focus on games that assess a skill but do not necessarily strive to teach it. Assessment games could be a good first step in getting more government agencies to be comfortable with the use of serious games. It would be a smaller role in a training program, while simultaneously providing a platform for collecting data to validate the effectiveness of games at targeting training goals and relevant skills. <Source: Government>

COMMERCIAL COLLABORATION OPPORTUNITIES

Some of the collaboration models proposed would involve funding an organization to build a game with a large budget. For those models, the funding is the primary motivation for participation. However, other models rely more on alternative motivation for participation that can greatly reduce the financial cost of the project. For example, if participants in a competition or capstone project can keep their intellectual property (IP) for commercial use, or if they can reuse some of the infrastructure they develop for subsequent projects, then a small budget for a government training project can become very appealing. A $10k–$50k budget that would look small as a means of sustaining a company in the long run can become a valuable seed investment if some of the output of that project can be reused for private purposes. For example, a developer might build a training tool that involves 3D first-person interaction with a disaster zone, then later reuse the 3D engine, scoring mechanics, character AI, and networking code for a survival game, a first-person shooter, or a fantasy-themed adventure. Even if the game itself is focused on serious purposes, much of the software infrastructure and art assets could be reused, offering a nonmonetary incentive for participation. <Source: Industry>

Sometimes, just adding a thin layer on top of an educational simulation can turn a boring experience into an engaging strategy game. Keep in mind that many entertainment games that are played purely for "fun" can involve managing massive operations research supply chains, balancing multi-object optimization pressures, social interaction and political maneuvering with other players, and a host of other activities that, to an outsider, sound more like work. One of the lessons from the success of strategy games is that hard decisions embedded in a believable world engage and motivate players, and such games typically feature decisions and tradeoffs that are near-perfect matches to the decisions and skills described by professional emergency managers as being core to a successful response. In fact, the category of "strategy games" is often defined as a game where players are given impactful decisions that do not have known correct answers, and for which the best answer depends heavily on context [18]. <Source: Industry, Academia >

In some cases, temporary access to professional-grade software development tools is an incentive for participation. For example, many commercial game competitions arrange a deal with the Unity tool providers (or similar game engine) to give all participants a temporary license for the professional version of the software. Many small developers see participation as an opportunity to learn those tools and build their skills, as well as a chance to earn prize money and add to their portfolio. <Source: Industry>

There is a large pool of inexpensive talent available in the independent video game community, which many of the models described in this document aim to leverage. Similarly, there is inexpensive talent that can be accessed for art and sound, both of which are easily overlooked but critical elements of creating an engaging, believable, and immersive experience for the player or student. For example, students at the Berkeley School of Music are world-class musicians who are often available to help with game-related projects at very low cost. <Source: Industry>

Consider involving the Higher Education Video Game Alliance (HEVGA) [19]. They have addressed similar issues of how to leverage games for advanced education, and could serve as a kind of center of excellence for supporting similar efforts with government funded training programs. <Source: Academia>

It will likely be very hard to get even small amounts of engineering time from medium-to-large video game companies without committing to high funding up front. They might be willing to share their existing data, but unlikely to add a new data collection field or collect a new kind of data. It might be possible to have industry share data with a national laboratory, who can collate it into a common form in a trusted environment, and then share anonymized aggregate results with academia for further study. In contrast, small and independent developers are likely to be very interested and available, making them an important resource to learn to leverage on the government side. <Source: Industry>

There can also be fears, founded or unfounded, of risks that taking government money might entail, especially if trying to create a commercial dual release (Model E). They might be forced to add or remove features by their sponsor that leave the game too boring for commercial success, or their resources might be entirely occupied in meeting the government contract, leaving them little time to properly design the commercial version, but legally liable if they fall short on the government version. For example, the company 38 Studios was sued for over $4 million after taking government funding and then struggling to release their product. Game projects always carry risk with them, and the cost of failure is usually wasting the time and effort that went into their creation. Adding legal penalties for contract violation on top of that risk could deter otherwise qualified participants. A model more like a game competition where unsuccessful products are weeded out, but not legally penalized, would help alleviate such concerns. <Source: Industry>

LESSONS FROM COMMERCIAL GAMES

Commercial game companies offer more than just experience in building the software behind games, often at a low cost. They also offer motivated and experienced professionals who have thought hard about engaging users while teaching them new systems. Modern video games are often complex systems that take many hours to learn, and one of the triumphs of the industry is in learning how to teach nonexperts (new players) how to use complex systems (the game), make long-range strategic choices about those systems (playing the game), and display large amounts of data in an accessible fashion (the

interface). They manage to routinely succeed on those fronts with an audience that is not only free to quit at any time, but which is actually paying to participate. Those lessons have obvious application to the field of emergency management training. <Source: Industry>

The video game industry has amassed techniques and skill at making games that are engaging (critical to education as well as entertainment) and effective at building communities. It is common for player-driven discussion forums to spring up online based on commercial video games, where players help each other improve their gameplay and master the game. Similarly, "modding" communities are common for successful games, where players create new content and elaborate scenarios for games they enjoy. In both cases, they volunteer their time to improve a game they paid for, simply because they find it engaging. In the realm of training emergency professionals, there is already a highly motivated user base who cares deeply about the topic. Game-based training methods could provide them an opportunity and a spur to document their experiences, discuss them, and collaborate across the country in improving their performance at those games. As that user base is filled more and more with people who grew up with video games, game-based training can provide a natural and familiar way for them to share knowledge and capture scenarios from their experience. <Source: Industry>

There have already been cases of knowledge sharing occurring in educational spaces. The EDGE game created by DHS and U.S. Army addressed active shooter scenarios in an online fashion very similar to an MMO. Users of that program ended up building an online community where players shared techniques, discussed real-world experiences, and forged interdistrict and interstate social connections and collaborations [20, 21]. One of the benefits of live exercises is the forging of social and organizational connections, and game-based training offers another tool toward that end. <Source: Government>

One lesson from commercial video games is in how one player games and multiplayer games offer different incentives that can drive different behavior and motivate different types of players. When a human faces another human in a game, they are often trying to one-up the other player – which may involve showing off skills more than actually focus on winning. When facing a machine AI, players are just trying to win, and often focus much more on learning good strategies. Choosing one or the other type of game can help motivate students using a game-based training tool, or encourage them to focus on elements that are important to the lessons. For example, a competitive player-versus-player mode can be effective for communities (such as air traffic control) with competitive employees, while solo games might be more suited to communities (such as public health) that typically employ people less interested in one-upping their colleagues. Characterizing the kind of student (and thus the kind of player) can draw on lessons learned from the commercial world and apply them to professional training [22]. <Source: Industry>

There is a related lesson about tailoring a game's look and feel to the target audience's expectations and familiar environment. Some people are going to prefer a display with a high density of numbers and controls, feeling like they are managing a complex system with detailed realism. Others may want a cleaner interface that uses natural actions (e.g., walking around in a 3D environment instead of selecting a destination from a menu). <Source: Academia>

TOOL SUPPORT FOR GAME-BASED TRAINING

Part of making game-based training techniques inexpensive, regardless of the collaboration model, is providing a toolkit or library of reusable algorithms. For example, Oak Ridge National Laboratory already has some models of how populations are likely to behave in disaster scenarios. Both Oak Ridge and Lawrence Livermore laboratories have models of the lethality of various hazards, such as the radiation protection factors of various building types. Lincoln Laboratory also has models and game templates that can be reused in a range of domains. Allowing the use of such tools outside of government development would require additional authorization, but there is a common practice and procedure for open sourcing materials for use in a public community when it is deemed to support national interests. <Source: National Laboratory>

Crowdsourcing talent from a pool of independent developers or volunteers from the player community is quite possible, but note that they will need some enablers. Two big enablers that will need to be provided as part of the project are (a) domain knowledge and/or tools to provide realistic data about elements of the domain, and (b) a platform or framework for hosting and sharing the game. Many training organizations have both on hand, so the main challenge is how to fold them into the project structure so that they are involved early. <Source: National Laboratory>

A common concern with game-based training is whether or not the games are realistic, affecting whether or not their lessons will transfer to real-world operations. Games developed with an iterative process offer an easy solution to this: having them played by domain experts early in the development cycle, so that the designers and developers get feedback on the game. Involving subject matter experts in the creation of educational materials, rather than relying on scientific studies, is a common practice for creating classroom and online training materials, and the same techniques could be applied to game-based training [23]. It is rare to hear a classroom course criticized for not being validated by a double blind study of its impact, but that is a common concern raised with serious games. While training materials should certainly be validated, that might be best achieved by tightly involving SMEs rather than attempting scientific-style validation after the game has already been created (and paid for). <Source: Academia, Government>

THE NEED FOR ALTERNATIVE COLLABORATION MODELS

It is worth noting that effective games, be they for entertainment or training, require engaging the player. Simply adding a score to a simulation, or adding “badges” to an exercise or quiz does not constitute an effective game-based training method. The game needs to integrate the material into a decision space, with the rewards being part of the game and not superficially added as an afterthought. Garnering that engagement is critical, and is an area where the video game industry has a long and successful history. Collaborating with video game developers, not just generic software developers, will be critical to creating effective game-based training. <Source: Industry>

The traditional sponsorship model is far too linear. It is not how games, or really any type of software, is built in industry. While the other models may appear unfamiliar to government agencies, they should be taken seriously. Also, many of the models do have successful precedents in government projects, even if they are not the dominant style of project [6]. <Source: Industry, Government>

A common stereotype that carries far too much truth in it is that anything made by the government will be boring, hard to use, and overpriced. To captivate an audience – key to making educational materials stick – it will be necessary to leverage private companies that have lived or died on their abilities to keep players engaged. The video game industry is full of such companies, and they can be a valuable asset to government programs producing user-facing tools, such as training materials. The successful companies understand how to build engagement into a product up front, rather than try to add it later or rely on a captive audience. <Source: Industry>

Rather than attempting to build a full system, training organizations should consider creating a core engine by conventional means (e.g., traditional project sponsorship, Model A) and then using some of the other proposed collaboration models to specialize that core system to the needs of individual training organizations. This approach would lower the barrier of entry for independent and small-scale collaborators from industry, giving them a way to contribute their talents without getting bogged down in a software project too big for their team. A training organization could provide the core infrastructure, such networking, graphics, and game engines up front, and then have the games industry collaborators build scenarios and extensions to the core system focused on individual training organizations' needs. It would greatly lower the cost of individual projects, and allow a much wider range of contributing companies to compete for those projects. The end result would be lower cost and higher quality, with a modest up-front investment. <Source: Industry>

Expecting individual agencies, especially relatively small training organizations, to build game-based training from scratch on each project may be unrealistic. Building effective games is a skill built up over time, and it would be inefficient to have every game-based training project rediscover that skill and reencounter the pitfalls associated with the field. Having a persistent organizing force (e.g., a center of excellence, Model G) could be extremely valuable to address a range of potential issues:

- Carry over experience between projects, so that lessons learned are not re-learned each time,
- Provide domain knowledge to guide collaborating organizations unfamiliar with emergency management,
- Cushion small contributors from government bureaucracy and procedures that they do not have the administrative depth to manage, and
- Provide government agencies with a single point of contact, experienced project management, and confidence that they will apply quality control and deliver an effective product on time.

The organization providing that cohesion could be an academic center of excellence, a non-profit company, a national laboratory or FFRDC, or a council of interested project managers within FEMA or DHS – a kind of "think tank" model. The organization could conduct some basic research to advance the state of the art, as well as provide a direct service in managing projects to create actual training materials. Ultimately, the change (to leveraging serious games) must come from within FEMA/DHS, but the organization supporting and enabling that change might be inside or outside the government. <Source: Industry, Academia, Government, National Laboratory>

It is common for an entertainment game that is ultimately successful to receive investor funding when it is still very rough – e.g., only 75% of a good design, plus needing development and polish. Investors and publishers have developed skill at identifying games that are promising and ready to be brought to completion. That model would map quite well to a government sponsorship model in which a national laboratory or academic center of excellence designs a game that targets appropriate skills and learning objectives, then passes it off to a commercial company to mature and complete the game. Companies like MassDigi and consortiums of independent developers could find game developers to finish prototypes developed by, say, national laboratories to target particular skills. <Source: Industry>

Consider a project structure in the style of a DARPA challenge. In that model, the job of the academics, national laboratories, and nonprofits would be to carefully define the soft skills to be targeted, but then leave a lot of freedom for how bidders meet those goals. Participants would receive a reward for winning but keep their IP, giving additional incentive for top performers to participate. This model would get people looking into those areas and potentially seed games that serve the role desired, with more creative freedom and a higher chance of creating a breakthrough technique. <Source: Government, National Laboratory>

Going through the normal RFP process can have a high (50%+) rate of failure on projects and could be even worse for newer approaches, such as game-based training. It might be better to instead focus on an industry-owned and government-influenced game. The government could provide loose guidance on the context and data to be collected, but end up with better graphics, sound, playability, and engagement. <Source: Government, Industry>

Whatever process is used, the sponsor needs to have a healthy acceptance of (and support of) risk and failure. Pursuing novel techniques always involves trial and error and lots of iteration, and giving performers “freedom to fail” is widely regarded as a core element of fostering innovation and modernizing a field. Sponsoring a larger number of projects at lower budget levels and with greater freedom given to the performers can provide better aggregate results and reliability than heavy-handed, large-budget, sole-source programs. <Source: Industry, Government>

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APPENDIX B. PRELIMINARY OPTIONS FOR STRUCTURING A GAME DESIGN COMPETITION (MODEL B)

This appendix explores two options for how to build a collaboration between government training organizations (especially those in DHS and FEMA dealing with emergency response) and the independent video game community via competitions. It proposes some structures for organizing and motivating such a collaboration on both sides of the fence. This document is meant to be a discussion point for getting feedback from both communities on the types of contests, rewards, and restrictions that would be appealing and acceptable. It is not intended to address the details of the overall project logistics, execution costs (other than the actual prize money), or legal phraseology.

Serious games have demonstrated the ability to target important skills that are otherwise very hard to teach, evaluate, or study. However, the experience of the serious games community has been that it is hard to reliably create effective games – be they serious game or entertainment games – and the best approach is often to cast a wide net. Some of the most effective new ideas come from young minds and unknown rising stars. Those are the kinds of people who can capture critical learning goals in a game while also making it engaging and immersive, and do so with new ideas. However, those are also the people who are typically not targeted by traditional government sponsorship, since they do not have the experience or corporate infrastructure to pursue government funding.

Our goal is to bring together these two communities – government agencies interested in modernized training via serious games and independent game developers with talent and fresh ideas. We want to do so with a mechanism that will be familiar to both sides. For the government side, this means having an experienced national laboratory oversee the project and provide the kind of guidance and reporting that is tried and true in government projects. For the independent developer side, this means accessing a large number of developers, letting them experiment without the overhead of dealing with government directly, and providing them loose guidance on the kinds of products we would like to see.

The solution is to do a contest or “game jam” with cash prizes, supported by a development toolkit, and supervised by researchers with experience in games, training, and emergency response. Tapping the independent community accesses a talented and often underpaid community of creative thinkers and software developers. The key insight is that relatively small amounts of prize money provided to a wide range of participants can generate a large number of new ideas at relatively low cost. Even if only a few of those ideas are any good, the end result will be higher-quality designs at a lower dollar cost than putting all the eggs in one basket up front with a single design and a single developer. Once this process has revealed the gems, they can be pursued in a traditional sponsored fashion with a much higher chance of project success and higher ultimate positive impact. This document addresses the question of how to motivate participation and structure the process of finding a wide range of ideas, down selecting those ideas to a solid core, and developing that core to a point ready for traditional sponsorship.

Reaching the independent game community is easy. A booth at the annual Game Developer’s Conference (GDC) or smaller gatherings such as the annual Boston Festival of Independent Games (BFIG), are inexpensive, effective means of getting the word out.

PITCH TO INDEPENDENT DEVELOPERS

The following pages outline thoughts on how to present the competition to the game development community. We have picked a rough estimate of a prize pool of $100k. A pool half that size would still be considered reasonable for a high-profile game competition, but the $100k level would stand out and gather a lot of attention in the community. These numbers are intended to give a concrete idea of what the prize structure would look like to participants, and what the total cost might be to a sponsoring agency. They are not intended to be recommendations, careful predictions, or to account for all costs associated with the project.

WANTED: Independent game developers and designers to help train emergency responders

- Sharpen your game creation skills
- Network with other designers and developers
- Earn some money
- Have a chance to earn a lot of money
- Create open-source software to help the community
- Make a positive impact on the world
- Have fun helping a humanitarian cause

We are seeking game designers and developers from companies of all sizes (or from no company at all!) to help create serious games to support emergency response. We want to see new and creative ideas for leveraging games to teach, evaluate, and study effective emergency response. We believe that effective serious games need to be both targeted and engaging, and we think that the best people to build such games are small companies and independent developers with fresh ideas and experience embedding strategic and social dynamics into games in a way that is fun.

The game you design can be from the point of view of first responders, emergency managers, survivors, adversaries causing the disaster, or any other perspective that you think will accomplish the target goals and be engaging to users. It does not have to be completely serious as long as it targets the appropriate skills. It is perfectly fine for zombies and elves to show up as part of creating situations that will target appropriate skills; but if you can make the game fun without zombies, that is good too.

All participants will receive information about the kinds of skills, dynamics, and data collection we are looking for in these games, and then will be given free rein to try out novel approaches. You will have access to the EM Dev Kit, providing resources to help you build games about disasters, including physics models, population models, and relevant art assets for common development platforms.

The best games will be selected for continued development; candidates will be offered a contract to continue development in collaboration with researchers, training professionals, and real first responders.

Accepting the contract is not mandatory to receive the prize money for earlier rounds, and a follow-on contract is not guaranteed. If you show you can make a creative and solid product, there are many government agencies looking to sponsor work in that area.

Participating teams must meet minimum quality standards to receive rewards, at the discretion of the judges. Judges will include emergency response professionals, researchers from a national laboratory, and other game designers and developers like you.

All source code, game concepts, and art assets submitted to the contest will be open sourced. They will therefore be available for both government use and private use going forward.

OPTION I: MULTIPLE QUALIFIER CONTEST

Round 1: Apply for participation

- 1 month timeline from announcement of topic
- No prize money at stake yet
- 40 teams qualify to continue to Round 2. They may recruit additional members for later rounds
- A template, list of goals, and sample games will be provided to guide the applications

Round 2: Build a quick prototype

- 1 month timeline
- Submissions are graded by the judges according to their training potential, creative novelty, and polish
  - Grade A: $5,000; outstanding product; up to 3 submissions can be As
  - Grade B: $1,500; solid product; up to 20 submissions can be B or better
  - Grade C: $500; meets minimum standards
  - Grade D: $0; does not meet minimum standards
- Max total prize pool = $46,500
- Up to 5 games rated A or B will move on to the next round

Round 3: Refine your prototype with input from professionals

- 1 month timeline
- Each design meeting expected quality standards: $10,000
- Best design will also be a candidate for a development contract to complete the game – there is no guarantee of getting a contract even if you win, but you will retain credit for your design and all prize money won in rounds 1 through 3
- Max total prize pool = $50,000.

Round 4: Finalize the game to be easy to play, easy to learn, and easy to extend to new scenarios

- 6–12 month timeline depending on the sophistication of the game
- Judges will decide if winners of Round 3 will be given a development contract or serve as consultants for a separate company contracted to finalize the game

- If hiring the winning team, they would probably be paid $100k–$500k depending on the type of game created
- If not hiring the winning team, the sponsoring agency would pursue a traditional single-performer contractor model, with the winning team retaining credit for the design and an opportunity to consult on the evolution of their idea – the contracted company would have the final say on all design decisions, but would be encouraged to take input from the contest winners
- This phase involved making the game easily extensible to handle new scenarios, so that there would be a very little cost to adapt it to integrate with other courses with similar goals

OPTION II: GAME JAM

Same as Option I, except Round 2 is changed as follows:

Round 2: Game jam at a local venue

- 2–3 day timeline, occurring over a single weekend
- Food will be provided for all participants, who will work on their games in a single room
- Submissions are graded by the judges according to their training potential, creative novelty, and polish
  - Grade A: outstanding product; up to 5 games can be As
  - Grade B: solid product; up to 10 games can be B or better
  - Grade C: meets minimum standards
  - Grade D: does not meet minimum standards
- *Every* team will receive a reward that scales up based on the *total* number of good games that emerge
  - Each A game: +$100 to each team
  - Each B game: +$25 to each team
  - Each C game: +$10 to each team
  - Each D game: +$0 to each team
- Max total prize pool = $38,000
- Up to 5 A or B grade games will be selected to move on to Round 3; those teams will move on to the next round, but all teams will get a prize boost because of their success

Note that the culture of game jams is usually one of collaboration, not competition. Many developers participate in order to network and learn from others, not to prove their superiority. As such, the prize structure for Option II encourages collaboration, but still gives credit to teams who produce good products.

One big benefit of a game jam is that the collaborative nature allows for more cross-fertilization of ideas. A team whose game is not coming together has a social and financial incentive to help other teams succeed, improving the overall quality of the final games. The main drawback of a game jam is that the short time-frame limits the resulting products to the talent in the room. With Option I, a participant might recruit someone to help fill a gap on their team, whereas there is no opportunity to do so with Option II. Both options can be effective for the right type of game. Option I is more likely to produce polished products, but will have less originality and brainstorming potential. Option II is more likely to produce a

new or clever solution, but the products will require more polish. With both options, the subsequent refinement stages (rounds 3 and 4) will be important to get the product ready for use.

Both of these options have been reviewed with independent game developers who are active in the community. They helped calibrate the prize structures to be “generous but not too good to be true” and define the structure to mesh with current “indie culture” while also maximizing the number of good games that emerge. Opinions were split over which option was more desirable, but all interviewees thought that both options would be effective.

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GLOSSARY OF TERMS AND ACRONYMS

AI	artificial intelligence
BAA	broad agency announcement
BFIG	Boston Festival of Indie Games
CBRNE	Chemical Biological Radiological Nuclear Explosive
DARPA	Defense Advanced Research Projects Agency
DHS	Department of Homeland Security
DHS S&T	DHS Science and Technology Directorate
DoD	Department of Defense
FEMA	Federal Emergency Management Agency
FFRDC	federally funded research and development center
game jam	a short (2–4 day) prototype-building competition for game developers
GDC	Game Developer's Conference
GOTS	government off-the-shelf
IMAT	Incident Management Assistance Team
IND	Improvised Nuclear Device
indie	independent software developer, either freelance or part of a very small company
IP	intellectual property
MMO	massively multiplayer online (a type of game)
MOBA	multiplayer online battle arena (a type of game)
modding	when a fan modifies a game after its release with sanctioning by the publisher
NUSTL	National Urban Security Technology Laboratory
RFP	Request for Proposals
RTS	real-time strategy (a type of game)
SME	subject matter expert

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14. ABSTRACT

In this document, we describe seven programmatic structures that can be leveraged to create game-based training materials. We describe the tradeoffs of the different development approaches, with the goal of helping agencies interested in serious games select an appropriate model for collaborating with partners. With an understanding of the possible collaboration models, we believe that agencies will be able to explore the use of game-based training with modest budgets and with a tolerable level of project risk.

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